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(54) Title: SYSTEM AND METHOD FOR FAST GPRS FOR IPV6 COMMUNICATIONS
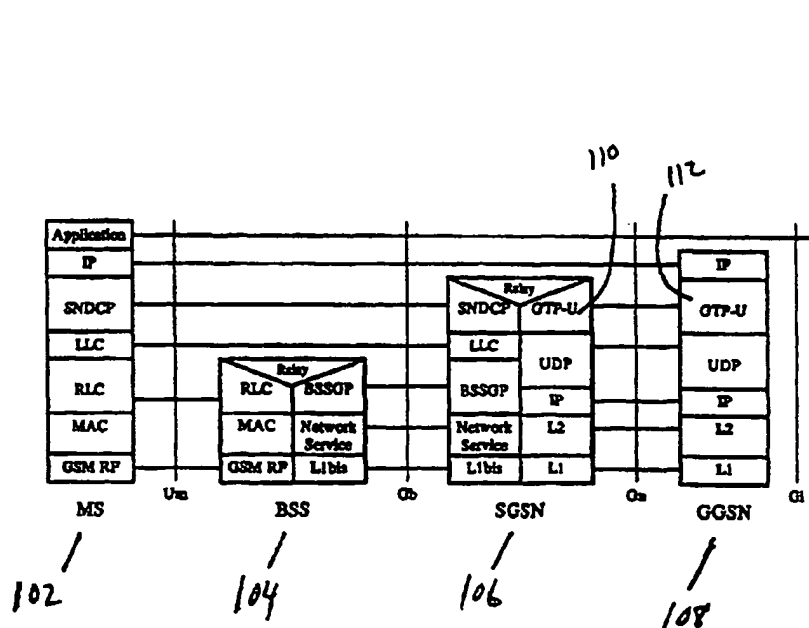
(57) Abstract: A system and method (100, Fig. 1) for fast GPRS for IPv6 which translates routing area Ids into a part of the routing prefix in IPv6 wherein the data from the mobile station (102, Fig. 1) can be translated to pass through a relay (104), a SGSN (106) and a GGSN (108).

SYSTEM AND METHOD FOR FAST GPRS FOR IPV6 COMMUNICATIONS

This application is being filed as a PCT International Patent Application in

5   the name of Nokia Inc., a U.S. national corporation and resident, on 25 February

2002, designating all countries except the US, and claiming priority to U.S. Serial

No. 60/271,190 filed 23 February 2001.

Field of the Invention

This invention relates generally to data transfer efficiency and more

10   specifically, to data transfer efficiency in GPRS cellular networks.

Background of the Invention

General Packet Radio Service (GPRS) systems such as Global System for

Mobile Communications (GSM) and Universal Mobile Telecommunications System

(UMTS) currently rely on two network elements: a serving GPRS support node

15   (SGSN) and a gateway GPRS support node (GGSN). A tunneling protocol called the

GPRS tunneling protocol (GTP) typically handles the correspondent flows between

the SGSN and the GGSN. One GGSN typically routes traffic between a mobile node

on the GPRS system and the correspondent flows on the GTP tunnel. Routing the

mobile node traffic and the correspondent flows through one GGSN causes

20   inefficiency in the routing of data within the GPRS system.

Currently available methods for streamlining routing include the application

of mobile Internet Protocol Version 6 (IPv6) mechanisms. However, there is

currently no means for GPRS systems to exploit the packet transfer acceleration

opportunities provided by mobile IPv6. A desirable goal would be to increase the

25   efficiency and cost effectiveness of the GPRS solution to mobility management.

Summary of the Invention

A system and method for fast GPRS for IPv6 is disclosed in which data

transfer efficiency is improved in cellular networks. In an embodiment of the present

invention, the cellular network relies on the GPRS infrastructure as defined and

30   standardized in the European Telecommunications Standards Institute (ETSI), and

on mobile IPv6 as currently being standardized in the Internet Engineering Task

Force (IETF). Mobile IPv6 techniques may be applied in the context of GPRS to

transform mobility management into a routing problem. For example, in an

embodiment of the present invention, the routing area identifier is translated into a

5   part of the routing prefix in IPv6. Similar mobile IPv6 techniques also may provide

an evolution path toward internetworking using native mobile IPv6.

Brief Description of the Drawings

FIGURE 1 is a diagram illustrating a GPRS system for GSM;

FIGURE 2 is a diagram illustrating a system for fast GPRS for GSM;

10   FIGURE 3 is a diagram illustrating a GPRS system for UMTS;

FIGURE. 4 is a diagram illustrating a system for fast GPRS for

UMTS;

FIGURE 5 is a diagram illustrating contents of an exemplary packet

format for router advertisements in a system and method for fast GPRS;

15   FIGURE 6 is a diagram illustrating an example of prefix information

coding in a system and method for fast GPRS;

FIGURE 7 is a diagram illustrating contents of an exemplary routing

area identification information element in a system and method for fast GPRS; and

FIGURE 8 is a diagram illustrating a table showing exemplary

20   routing area update request message content in a system and method for fast GPRS,

in accordance with the present invention.

Detailed Description of the Preferred Embodiment

A system and method for Fast GPRS for IPv6 in accordance with an

embodiment of the present invention is disclosed herein. In the following

25   description, numerous specific details are set to provide a thorough understanding of

the present invention. However, it will be evident to those skilled in the art that these

specific details need not be used to practice the present invention and alternative

embodiments are possible. In other cases, well-known structures and circuitry have

not been shown in detail to avoid unnecessarily obscuring the present invention.

30   In the following detailed description of exemplary embodiments of

the invention, reference is made to the accompanied drawings, which form a part

hereof, and which is shown by way of illustration, specific exemplary embodiments

of which the invention may be practiced. Each embodiment is described in

sufficient detail to enable those skilled in the art to practice the invention, and it is to

be understood that other embodiments may be utilized, and other changes may be

5   made, without departing from the spirit or scope of the present invention. The

following detailed description is, therefore, not to be taken in a limiting sense, and

the scope of the present invention is defined only by the appended claims.

Throughout the specification and claims, the following terms take the

meanings explicitly associated herein, unless the context clearly dictates otherwise.

10   The meaning of "a", "an," and "the" include plural references. The meaning of "in"

includes "in" and "on." The term "operator" refers to any technician or organization

that maintains or services an IP packet based network. Referring to the drawings,

like numbers indicate like parts throughout the views. Additionally, a reference to

the singular includes a reference to the plural unless otherwise stated or is

15   inconsistent with the disclosure herein.

The invention provides for accelerating packet transfer in GPRS

systems with the use of a specific mobility management technique in mobile nodes.

The invention has minimal impact on the GPRS node development. A minor

modification to the GPRS core network (UTMS Radio Access Network "UTRAN"

20   in UMTS and SGSN in GSM) is also necessary. The resulting system is more

efficient and cost effective than the actual GPRS solution. The basic idea is that the

routing area identifier is to be translated into a part of the routing prefix in IPv6. The

result is a combined GPRS and IPv6 routing infrastructure. This enables IPv6

mobility to be used as an alternative to GPRS mobility.

25   Currently, GPRS (GSM/UMTS) systems such as those shown in

FIGURE 1 and FIGURE 3 respectively, do not exploit the opportunities given by

mobile IM, that transforms mobility management into a routing problem. In

FIGURE 1, the GSM system 100 includes MS (mobile node) 102, BSS (Base

Station Subsystem) 104, SGSN 106, and GGSN 108. In FIGURE 3, a UMTS system

30   300 includes MS (mobile node) 302, UTRAN 304, 3G-SGSN 306, and 3G-GGSN

308.

The current GPRS system relies on two network elements, SGSN

106, 306, and GGSN 108, 308, and the tunneling protocol called GTP between them

(shown as GTP-U 110, 112, 310, 312). The traffic between the mobile node and the correspondent flows goes through a tunnel that is typically anchored into one GGSN 108, 308. This causes inefficiency in the routing of data within the GPRS system. By applying mobile IPv6 more straightforward mechanisms a more streamlined

5   routing could be achieved and also an evolution path towards interworking with native mobile IPv6 based networking could be accomplished.

The invention bypasses the usage of the GTP (in GSM) and GTP-U (in UMTS) protocol for data routing in GPRS. GTP is not specifically tailored for IP level mobility handing and is hence not optimal for native mobile IPv6 (or mobile

10   IPv4). The technique that we propose is a "cut-through" in the GPRS network to extract IPv6 traffic out to the conventional Internet network before it enters into GTP. The proposed solution can co-exist with the GPRS network and relies on GPRS signaling, but handles traffic from mobile IPv6 capable nodes differently. For more information on GTP, see 3GPP TS 29.060 V3.6.0 (2000-09) Technical

15   Specification Group Core Network; General Packet Radio Service (GPRS); GPRS Tunneling protocol (GTP) across the Gn and Gp Interface (Release 1999), which is herein incorporated by reference.

Example embodiments of systems for Fast GPRS for IPv6 in accordance with the present invention are shown in the block diagrams 200 and 400

20   of FIGURE 2 and FIGURE 4 respectively. In an embodiment of the present invention, an improvement is made to Mobile IPv6 by notifying the IP6 layer of mobility within the cellular network rapidly, which improves GPRS routing and throughput by using Mobile IPv6 instead of GTP. (See 204 in the GSM type GPRS system 200 of FIGURE 2 and see 404 in the UMTS-type GPRS system 400 of

25   FIGURE 4.) An additional advantage of FAST GPRS is that it co-exists with the GPRS and it is hence possible to use at some times the FAST GPRS and in others come back to the conventional solution. Interworking between GPRS networks and native mobile IPv6 networks would be easier. For more information on combining GSM and Mobile IP Mobility Handling, see 3GPP Technical Specification Group

30   Services and System Aspects; Combined GSM and Mobile IP Mobility Handling in UMTS IP (3G TR 23.923 version 3.0.0), which is herein incorporated by reference.

FIGURE 4 is a diagram illustrating a system for fast GPRS for UMTS in accordance with an embodiment of the present invention. The Media

Access Control (MAC) layer 206, 208, 404, 406, 408 in Fast GPRS nodes has the role of routing area advertisement translation from the GPRS system 200, 400 to the Mobile IPv6 router advertisements messages (ICMPv6). When the MS (mobile node) 302 receives a Routing area change notification from the SGSN 202 or

5   UTRAN 402, its MAC layer adaptation creates locally an IPv6 router advertisement message 500 to the IPv6 layer. The MAC layer adapter 404 uses Routing Area Identifier to create the needed prefix information element 600 for the IPv6 Router Advertisement message 500. When the IPv6 layer of the mobile node receives this message it configures a new care of address based on the prefix 602 that was created

10   by the MAC layer adapter. The IPv6 layer responds normally according to Mobile IPv6 specifications by sending a Binding Update. The MAC layer in the node encapsulates the binding update into the GPRS routing area request. For more information, see 3GPP TS 23.060 V3.5.0 (2000-10) Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS). Service

15   Description (Release 1999), which is herein incorporated by reference.

          For this there are at least two alternative embodiments. Either a new Information Element Identifier is introduced for Routing Area Update message that carries all mobile IPv6 signaling or a new Update type is introduced. In the latter case, this new Routing Area Update Request type should be set to a unique globally

20   recognized (i.e. to be standardized and reserved for this purpose) value. For example, the value '11', may be used in order to indicate that it is not a normal routing area update request, but that it *needs specific* processing for the mobile IPv6 context. This is described in more detail below. If the GPRS system does not recognize or support the request for a mobile IPv6 context set up, then the GPRS

25   system rejects the special routing area update request and the mobile node falls back to the normal Packet Data Protocol (PDP) address activation process requesting IPv6 context from the normal GPRS.

          In case the network recognizes the Fast GPRS routing area update request containing the Mobile IPv6 Binding Update, it is sent by the Access router

30   (Radio Network Controller "RNC" in UMTS or SGSN in GSM) to its Home agent as part of standard mobile IP operation. All IP traffic that uses this mobile IPv6 PDP is extracted in SGSN (or alternatively in RNC) and routed directly into Internet. Note that the Mobile node should send (in case FAST GPRS routing area update

request is accepted by the network) a second routing area update request with the type set to periodic or new routing area update to update the normal GPRS lower layers.

FIGURE 8 is a table 800 showing examples of the message content

5   of a Routing Area Update Request in a system and method for Fast GPRS in accordance with an embodiment of the present invention.

For authentication reasons, it is necessary to delay Mobile IPv6 Binding updates sent to the home agent until the GPRS authentication is verified. The sending of Binding Update Acknowledgement (BACK) should be delayed until

10 Routing Area Update Accept message from a SGSN or RNC is sent. The BACK message is carried in the Routing Area Update Accept message.

The invention necessitates a MAC layer adapter in the Mobile node supporting IPv6 on top of GPRS. The role of this MAC layer adapter is to generate Internet Control Message Protocol (ICMP) v6 Router advertisement messages from

15 GPRS Routing area update messages. The Prefix advertised by this router advertisement is taken from the GPRS MM (Mobility Management) layer and is called the Routing Area Identifier (RAI). An example of a Routing Area Identification information element identifier (IEI) 700 is shown in FIGURE 7. The adapter converts the RAI into advertised network prefixes in the corresponding

20 ICMPv6 Router Advertisement messages.

At the SGSN/RNC there is a substantially similar adapter layer that extracts Binding Update messages from the Routing area updates received by the mobile node. It creates standard Binding Update messages for the Home Agents. Here the Authentication Header is calculated based on the GPRS key distribution

25 mechanism.

A second modification may be done in the UTRAN network side for UMTS and in the SGSN for GSM networks for the purpose of extracting IP traffic from the mobile IPv6 node. This can be done based on the specific PDP context that was activated, or alternatively, an SGSN/RNC could check the IPv6 source address

30 of the packets received from the mobile node. If the source address contains a prefix under the responsibility of the SGSN or UTRAN, then the packet is simply routed out of the GPRS network into the Internal infrastructure. A mapping entry between the IPv6 address and mobile node is stored in the SGSN/UTRAN. Similarly, when

packets arrive at the SGSN or UTRAN, the IPv6 layer fetches the adequate mobile node context and if it exists, forwards the IPv6 packet in the conventional SNDCP/PDCP layer format. From the network side (SGSN or RNC in UTRAN), special routing area update requests are received from a mobile node asking for the

5   Fast GPRS service. With the normal GPRS identification procedure (Identification Request message), it is possible to poll the node to determine whether the equipment belongs to a particular party, manufacturer, or if the user has a license agreement with that party. Such identification procedures may be useful for a variety of reasons, including determining whether or not another party has implemented an

10   embodiment of the present invention.

FIGURE 5 is a diagram illustrating contents of an exemplary packet format 500 for router advertisements in a system and method for fast GPRS in accordance with an embodiment of the present invention. The packet format 500 for router advertisements is defined in RFC 2461. Since the mobile node's MAC layer

15   generates the frame, the link local source address could set to zero or alternatively to a link local address that was derived from Routing Area Identifier. This is to distinguish between other router advertisements arriving from the GGSN or other routers. The Router Lifetime should contain the frequency with which the mobile node receives information about Routing Area Updates. Typically, this depends on

20   the physical layer. No Reachable Time field should be set. The Retrans Timer contains the value that has been assigned for the Ready Timer Function inherent to GPRS Mobility Management.

The destination address contains the anycast all-nodes multicast address. The Hop Limit should be set to zero. The Prefix Information contains the

25   Value and length of the prefix as deduced from the Routing Area Update. The Prefix information may be coded as shown in FIGURE 6. FIGURE 6 is a diagram illustrating an example of prefix information coding in a system and method for fast GPRS in accordance with an embodiment of the present invention.

The L bit has to be set to one. The A bit has to be set to one. Valid

30   Lifetime and Preferred Lifetime should be set to the Requested READY timer value from the GPRS environment.

The prefix value is literally taken from the RAI (Routing Area Identifier) as defined in the ETSI recommendations (23-060, 24008). The octets 2 to

7 are inserted in the Prefix so that the octet one represents the most significant octet

and octet 7 the least significant. Choosing prefixes will depend on each operator's

routing plan. FIGURE 7 is a diagram illustrating contents of an exemplary routing

area identification information element in a system and method for fast GPRS in

5   accordance with an embodiment of the present invention. Routing Area Identity

(RAI), defined by an operator, identifies one or several cells. In one embodiment

that employs GSM, RAI is broadcast as system information. In another embodiment

that employs UMTS, RAI is broadcast to mobile nodes in Radio Resource Control

(RRC) Idle mode, and is notified to mobile nodes in RRC Connected mode on

10   established RRC connections as MM system information. The acronyms listed in

the equations below are as follows: Location Area Identity (LAI), Mobile Country

Code (MCC), Mobile Network Code (MNC), Link Access Control (LAC), Radio

Admission Control (RAC), Cell Identity (CI), and Cell Global Identification (CGI)

15   LAI = MCC + MNC + LAC.

                            RAI = MCC + MNC + LAC + RAC.

                            CGI = LAI + CI (GSM only).

20

                    When a packet is received in the Sub-network Dependent

Convergence Protocol (SNDCP) layer for the SGSN, the source is checked before

tunneling through GTP. If the mobile node sending the packet has made a Fast

GPRS request, then the packet is taken out from the GPRS network and routed

25   directly into the IPv6 Internet. The SGSN stores the correspondence between the

Service Access Point (SAP), Temporary Logical Link Identity (TLLI) and GPRS

context with the newly assigned IPv6 address.

                    When packets arrive from the IPv6 network with a destination prefix

equal to that of the SGSN and the SGSN recognizes the Destination Address to be

30   already registered and has an active IPv6 context with Fast GPRS functionality, it

forwards the packet through the normal SNDCP encapsulation procedures.

                    The SGSN performs the authentication procedure, and the RNC

performs the ciphering procedure based on the algorithm for UMTS. In one

embodiment, the SGSN is third generation, i.e., 3G-SGSN. When the RNC in
UTRAN receives a routing area update from a new mobile node, it checks if the
Routing Area Update Request type corresponds to the FAST GPRS method. If so,
the RNC forwards the Routing Area Update to the SGSN and when the Bearer

5   Access is granted by the SGSN, the RNC applies the same procedure as in the GSM
case: It looks for every PDCP packet coming from the node and pulls it out from the
GPRS to the Internet. When packets are received for the specific mobile node from
outside the network, the RNC determines if a bearer exists for that mobile node. If
so, the RNC forwards the packet on top of the PDCP protocol using the appropriate

10   compression as specified in the PDCP protocol.

The MAC procedures have been described above. The Binding
Update messages may be sent at the frequency of the Routing Area Update
Requests. FIGURE 8 is a diagram illustrating a table showing exemplary routing
area update request (Fast GPRS) message content in a system and method for fast

15   GPRS in accordance with an embodiment of the present invention. In one
embodiment, the Binding Update is inserted in the Routing Area Update Request in
the field number 31. In this case, the Update Type information element identifier
(IEI) can be set to 11 to prevent confusion with non-Fast GPRS network elements.
Alternatively, a new IEI that denotes mobile IPv6 binding update/acknowledgement

20   messages can be allocated. The Routing Area Update Accept Message can be sent
upon the reception of a Binding Acknowledgment from the Home Agent in Mobile
IPv6 or sent directly to the node. In one embodiment, this choice (selection) is
available to the operator.

The above specification, examples and data provide a complete

25   description of the manufacture and use of the composition of the invention. Since
many embodiments of the invention can be made without departing from the spirit
and scope of the invention, the invention resides in the claims hereinafter appended.

WE CLAIM:

1.   A method for fast GPRS in a GPRS network that includes an IPv6 layer and a MAC layer, comprising:

(a)   in response to receiving a GPRS routing area update message at a mobile node, employing an adapter at a MAC layer of the mobile node to generate a router advertisement message, wherein the router advertisement message is communicated to an IPv6 layer on the mobile node;

(b)   generating a care of address at the IPv6 layer on the mobile node based on a router advertisement message; and

(c)   employing the adapter at the MAC layer of the mobile node to encapsulate a Mobile IPv6 Binding Update message into a routing area request, wherein the routing area request is communicated to the GPRS network, and wherein the routing area request includes an information element associated with a predetermined routing type that is employed by the GPRS network for IP level routing with the mobile node.

2.   The method of Claim 1, wherein the routing area request includes signaling information for mobile IPv6 processing.

3.   The method of Claim 1, further comprising when the predetermined routing type in the routing area request is recognized by the GPRS network, the Mobile IPv6 Binding Update message contained in the routing area request is forwarded to a Home Agent for the mobile node.

4.   The method of Claim 3, further comprising delaying the forwarding of the Mobile IPv6 Binding Update message to the Home Agent until authentication by the GPRS network.

5.   The method of Claim 4, wherein the delaying includes delaying the sending of a Binding Acknowledgement message until a Routing Area Update Accept message is generated by an SGSN on the GPRS network.

6.   The method of Claim 4, wherein the delaying includes delaying the sending of a Binding Acknowledgement message until a Routing Area Update Accept message is generated by an RNC on the GPRS network.

7.   The method of Claim 3, further comprising when the Mobile IPv6 Binding Update message is forwarded to the Home Agent, the mobile node provides a second routing area request to the GPRS network

8.   The method of Claim 7, wherein the second routing area request includes a predetermined type, including one of periodic and new routing area update.

9.   The method of Claim 1, further comprising indicating that Mobile IPv6 processing is to be used by the GPRS network for handling the routing area request.

10.   The method of Claim 1, further comprising when the information element is unrecognized by the GPRS network, employing the PDP address activation process to request IPv6 context set up on the GPRS network.

11.   The method of Claim 1, wherein information for care of address generation is included in the routing area request.

12.   A system for fast GPRS processing in a GPRS network that includes an IPv6 layer and a MAC layer, comprising:

(a)   a MAC layer module on a mobile node that generates a router advertisement message in an IPv6 format in response to receiving a GPRS routing area update message, wherein the router advertisement message is communicated to an IPv6 layer of the mobile node;

(b)   the IPv6 layer module on the mobile node that generates a care of address in response to receiving the router advertisement message from the MAC layer module; and

(c)   an encapsulation module at the MAC layer of the mobile node that encapsulates a Mobile IPv6 Binding Update message into a routing area request, wherein the routing area request is communicated to the GPRS network, and wherein the routing area request includes an information element associated with a predetermined routing type that is employed by the GPRS network for routing subsequent communication with the mobile node.

13.   The system of Claim 12, further comprising a mobile IP module that includes signaling information for mobile IPv6 processing in the routing area request.

14.   The system of Claim 12, further comprising a module that provides a second routing area request to the GPRS network when the Mobile IPv6 Binding Update message is forwarded to a Home Agent.

15.   The system of Claim 14, further comprising a module that delays the forwarding of the Mobile IPv6 Binding Update message to the Home Agent until authentication by the GPRS network.

16.   The system of Claim 14, further comprising a module that provides a second routing area request to the GPRS network when the Mobile IPv6 Binding Update message is forwarded to the Home Agent.

17.   The system of Claim 12, wherein the GPRS network includes a selected one of GSM, CDMA, TDMA, W-CDMA, 3G-CDMA and UMTS protocols.

18.   The system of Claim 12, further comprising a module that determines when Mobile IPv6 processing is indicated for handling the routing area request.

19.   The system of Claim 12, further comprising a module that includes information for care of address generation in the routing area request.

20.   A method for fast GPRS in a GPRS network that includes an IPv6 layer and a MAC layer, comprising:

(a)   means for employing an adapter at a MAC layer of a mobile node to generate a router advertisement message in response to receiving a GPRS routing area update message at a mobile node, wherein the router advertisement message is communicated to an IPv6 layer on the mobile node;

(b)   means for generating a care of address at the IPv6 layer on the mobile node based on a router advertisement message; and

(c)   means for employing the adapter at the MAC layer of the mobile node to encapsulate a Mobile IPv6 binding update message into a routing area request, wherein the routing area request is communicated to the GPRS network, and wherein the routing area request includes an information element associated with a predetermined routing type that is employed by the GPRS network for IP level routing with the mobile node.

FIG. 1
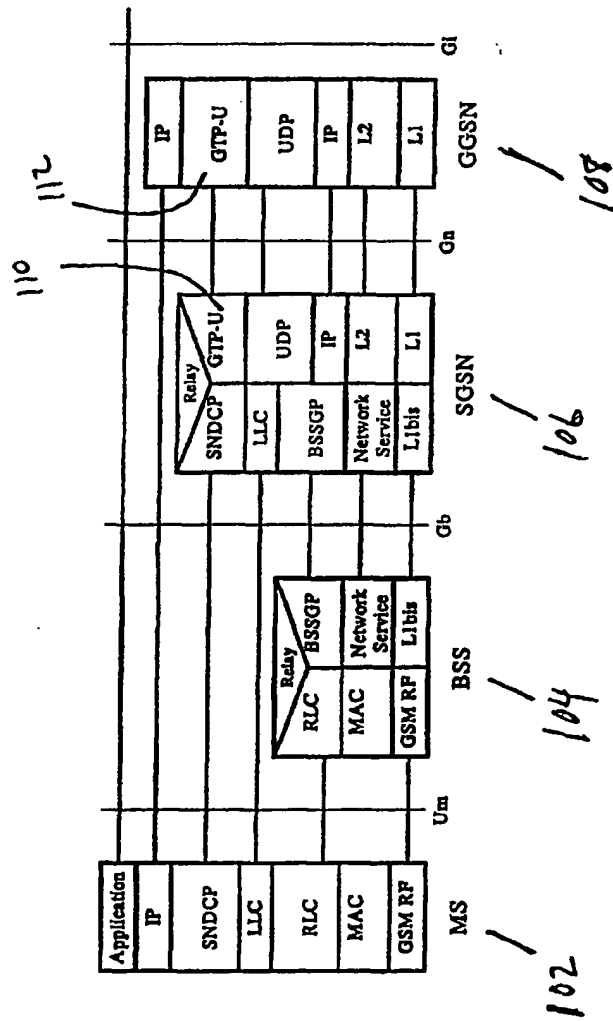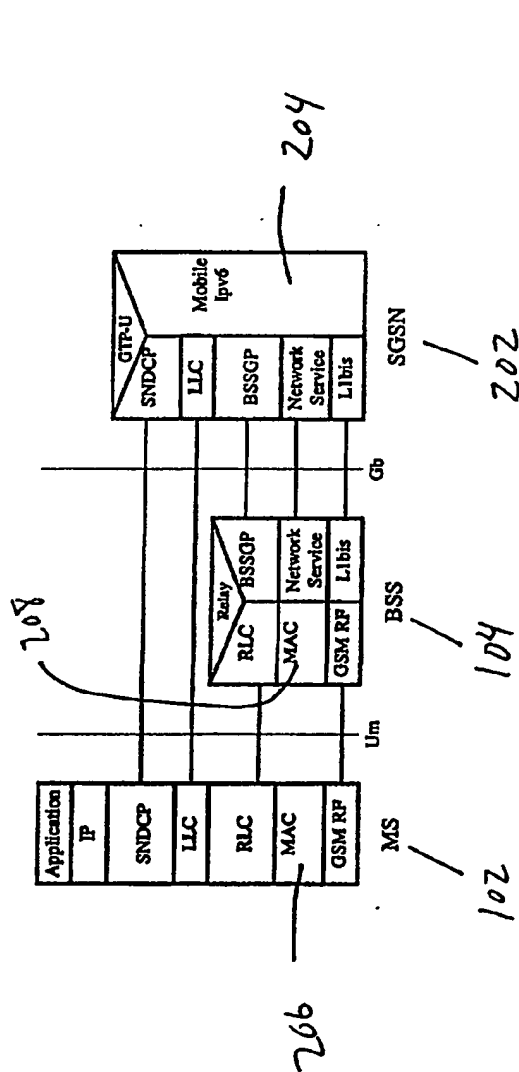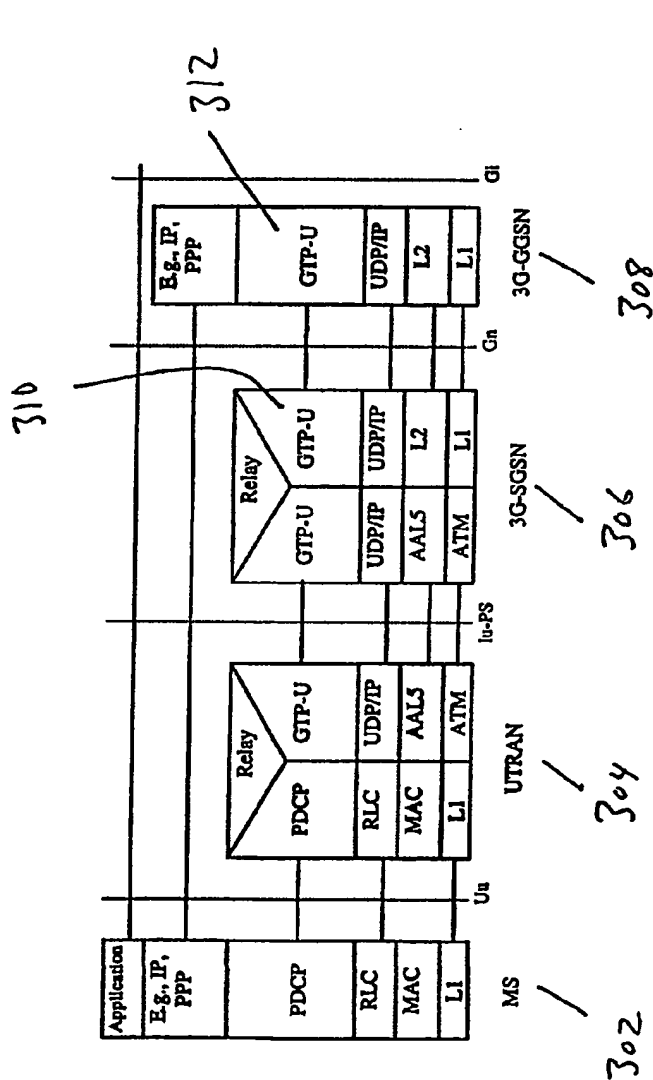
FIG. 2

FIG. 3